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BEFORE

HOUSE TRANSPORTATION AND INFRASTRUCTURE COMMITTEE
HEARING ON
CLIMATE CHANGE AND ENERGY INDEPENDENCE: TRANSPORTATION AND
INFRASTRUCTURE ISSUES

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On behalf of United Technologies Corporation (UTC), I am pleased to testify at today's hearing, "Climate Change and Energy Independence: Transportation and Infrastructure Issues." The approach Congress and businesses adopt to tackle the climate change issue will present both challenges and opportunities.

UTC is a global diversified company, headquartered in Hartford, Connecticut. We build aircraft jet engines at Pratt & Whitney, helicopters at Sikorsky, elevators at Otis, heating and air conditioning systems at Carrier, fire protection and security systems at UT Fire and Security, aircraft and space systems including aircraft electric power and cabin temperature/pressure and even the space suits for the American space program at Hamilton-Sundstrand. Finally at UTC Power, we build hydrogen powered fuel cells and a line of on-site co-generation products of particular interest today.

The common denominator of everything we do is to convert energy to useful work, whether elevators or air conditioning or aerospace. So we're highly alert to the energy and conservation agenda for stationary and transportation applications.

UTC is a member of the Fortune 50 and the Dow Jones Industrial Average index. We bring a credible voice to the policy debate, as we've been a leader in addressing climate change by reducing energy use in our global operations and incorporating energy efficient innovations in our products.

Since 1997, UTC worldwide energy use is down by 19 percent in a company that has doubled its size. We are focusing on energy conservation and climate change for our new 2010 environmental goals to reduce absolute greenhouse gas emissions by an additional 12 percent in the next four years. We expect to achieve this aggressive target in part with significant energy conservation projects and with investments in technologies to create power from waste heat. UTC will also extend its influence across the value chain to reduce negative environmental impacts by its factories, products and suppliers.

UTC's products can be found in almost every country on earth. And since many have long lifespans, we've worked hard to improve the efficiency of products to minimize our environmental impact. Given the long useful life of our products, even small improvements in efficiency yield significant long term benefits. Our 2010 goals include a ten percent reduction in product packaging and a ten percent increase in the operating energy efficiency of the portfolio of products we sell.

A national climate change program should include flexible market-based policy measures but it must be coupled with strong support for research, development, demonstration and commercialization of emission-reduction technologies. We believe emerging technologies provide the answer to climate change problems; that is why we dedicate nearly \$3 billion annually to research and development -- to identify and develop those innovative technologies. A coordinated federal approach to accelerate the development of these advanced and emerging energy technologies is a key solution to reduce greenhouse gas emissions.

In my statement, I describe how a technology focus can help achieve climate change and energy goals in the following areas: aviation, surface transportation and buildings – and, relevant to this panel, I'll discuss a couple of important opportunities related to surface transportation and buildings that are relevant to the aviation industry.

AVIATION

Aviation is a global industry. On a given day, an airplane can literally be in multiple countries and on multiple continents. In this international arena, we must compete in with the best products we can develop. It also means that we must work with the international community, and organizations like the International Civil Aviation Organization (ICAO). ICAO has 190 contracting states, all impacted by aviation, and consequently they need to have input on actions taken to regulate aviation's environmental performance.

The Kyoto Protocol stipulates that the limitation or reduction of greenhouse gas emissions from international aviation be pursued through ICAO. ICAO is currently working on developing a global response to aviation and climate change and UTC supports these activities and believes ICAO is the appropriate organization to deal with the issue. ICAO's Committee on Aviation Environmental Protection (CAEP) has intensified its activity at developing international solutions to address the issue of aviation's impact on climate change.

Pratt & Whitney is an active participant in the CAEP Process and supports global solutions to global problems. Pratt & Whitney participates in all CAEP Working Groups and Task Groups dealing with climate change, local air quality and community noise and considers ICAO, through CAEP, to be the preferred body to establish guidance and policy to address environmental issues. We are taking a leadership role in developing new technologies, such as our unique geared turbo fan (GTF), that will offer significant improvements in fuel efficiency and thereby directly reduce carbon dioxide (CO₂) emissions.

Fuel Efficiency and Emissions

My colleague, Rich Altman, will speak in detail about alternative fuels for aviation, and I want to state our support for alternative fuels industry initiatives. We are an active participant with the industry team and are supporting the Commercial Aviation Alternative Fuels Initiative (CAAFI) as an instrument to address civil and military aviation concerns. The effort is especially important as we consider our nation's energy independence.

While we remain firmly committed in our support to alternative fuel initiatives, we believe the more immediate path to lower CO₂ emissions for aviation is through engine efficiency gains. When we talk about reducing aircraft emissions, we talk in terms of fuel efficiency. The connection between fuel burn, or fuel economy, is directly related to CO₂ output. Since 1971, aviation fuel efficiency has tripled, which is double the improvement automobiles have made over the same time period. Better fuel efficiency means less emissions, but clearly also lower operating costs. At \$120 billion per year, fuel represents more than 25 percent of all airline industry operating costs. In 2006, fuel overtook labor as the industry's largest expenditure which further induces operators and manufacturers to improve fuel efficiency.

Improved Engine Efficiency for Next Generation Single-Aisle Aircraft

Pratt & Whitney will have in place production-ready engine technologies for the next generation of single-aisle aircraft. Key elements of our technology plan include our geared turbofan now under development, a next generation TALON™ (Technology for Advanced Low NOx) low-emissions combustor, an advanced high-pressure compressor, and a suite of high-pressure turbine technologies. Let me describe the first two of these in a little more detail.

Geared Turbofan Technology

In a geared turbofan engine, a reduction gear allows the fan to operate independent of the low-pressure compressor and turbine. The fan can operate at a slower speed for lower noise and its diameter can be larger to achieve a higher bypass ratio for greater efficiency and fuel economy. At the same time, the low-pressure compressor and turbine can operate at higher speeds to achieve their best efficiency. At faster speeds, the turbine can power the compressor and fan with fewer stages to reduce part count, component weight, and operating costs. The compressor also benefits by fewer parts, lower weight, and lower operating costs.

The geared turbofan engine, building on nearly 20 years of technology development, allows the engine's low-pressure spool to operate at high speeds for peak efficiency, while the fan operates at slower speeds for both optimum efficiency and significantly lower noise. This engine configuration will deliver:

- 12% reduction in fuel burn over best current single-aisle engines;
- 55% reduction in NOx emissions over ICAO 2008 standard;
- 20dB reduction in noise over ICAO Chapter 4 requirements; and
- 40% reduction in engine maintenance cost

A 12% reduction in the aviation industry's fuel usage would save \$14.4 billion a year – a figure which would exceed the current profitability of the industry.

TALON Combustor Technology

Our rich-quench-lean (RQL) TALON combustor uses advanced fuel/air atomizers and mixers, metallic liners, and advanced cooling management to lower emissions during takeoff, high-altitude cruise, and landing. Our newest version – called, TALON X – is being developed in partnership with NASA and has demonstrated extremely low emissions, while at the same time ensuring smooth ignition both at sea level and altitude conditions, and excellent reliability. It is extremely important that as new technologies to reduce emissions are introduced, we maintain or improve the current excellent safety record of our industry's products. I can assure you that we, along with the FAA, will ensure this happens.

EcoPower Wash

Regular washing of aircraft engines can also provide real benefits. During the course of normal operations, airborne material is ingested into the engine and deposited on the internal parts. Over time, this material builds up and leads to a drop in fuel efficiency. This performance deterioration can be restored by regular engine washing. Pratt & Whitney has made this once labor and time intensive process operationally efficient with EcoPower Engine Wash Services. Without impacting our airline customers' tight schedules, we can perform engine washes anywhere on the tarmac in about an hour.

EcoPower water wash restores on-wing fuel efficiency using pure, atomized water to remove the contaminants instead of traditional toxic chemicals as cleaning agents. The technology allows the process to be completed as much as six times faster than traditional engine-washing systems while capturing the water for re-use. Washing every airliner engine twice a year with Pratt & Whitney's EcoPower engine wash could save over half a billion gallons of fuel - the equivalent of over 10 billion pounds, or 5 million tons of carbon dioxide.

Fuel Cell Opportunities at Airports

With the high demand for aviation travel predicted to continue, our airports are expanding. At the same time, airports are coming under increasing pressure to reduce air pollutants. We need to work with them to make those reductions, bringing benefits to the airport and local community. In some areas of the country, air pollution is the limiting factor for airport growth. Major sources of air pollution at an airport are not limited to aircraft operations, where we make progress by improving engine efficiency and emissions reduction. Ground vehicles such as automobiles, shuttles, and public transportation for people and goods and ground support equipment such as aircraft towing, baggage handling, maintenance repair, refueling and food service also contribute to the energy and emission footprint of our airports.

With more than 40 years of experience, UTC Power is the world leader and the only company that develops and produces fuel cells for applications in each major market: on-site power, transportation and space flight. Fuel cells provide an opportunity to address a variety of U. S. energy needs including: reducing dependence on foreign oil; delivering assured, high quality reliable power; decreasing toxic air and greenhouse gas emissions; and improving energy efficiency.

Fuel cells and other clean power technologies like microturbines can be used to reduce air emissions in the following airport applications:

Buses – To shuttle passengers to and from airport parking and rental car centers

Ground Support Equipment (GSE) – In light, medium and heavy-duty applications for baggage handling, maintenance, fuel delivery and food service

Aircraft tugs – To move planes to the runway and back thus allowing aircraft to shut down their main engines. There is also the potential to over-size the fuel cell so electrical power can be exported to aircraft to reduce the use of auxiliary power units (APU).

Electrifying gates – At terminal facilities and providing conditioned air

Terminal and adjacent hotel operations -- Base load power as well as combined cooling and heating

Backup power systems – Can operate 24/7 in applications as described above and eliminate the need to have diesel back up generators. Because this equipment is operated on natural gas, it burns cleaner than diesel and provides an additional measure of reliability due to power diversity (i.e., grid and onsite power).

Uninterruptible Power Supply (UPS) – Small hydrogen fuel cells can be used as back up devices to replace need for lead acid batteries to support critical airport instrumentation and communication devices.

These clean technologies can be used separately or in combination with one another to reduce overall air pollution. Many of these measures provide for greater energy efficiency and therefore reduce carbon dioxide emissions. For example, UTC Power's PureCell™ and PureComfort® systems provide total efficiencies of greater than 80 percent when waste heat is captured and used for cooling and heating

Airport vehicles typically stay within the immediate proximity of the facility and go to a central location for fueling. This provides the opportunity to create a hydrogen infrastructure with economies of scale. As such, airports can be a nucleus to build a small city that uses hydrogen in a clean and efficient manner. This can act as a demonstration site that is a model for the future.

We want to recognize the Committee's attention to low-emission vehicles with the VALE program in the 2003 FAA Reauthorization bill. We look forward to building on that initiative and working with the Committee during this year's FAA Reauthorization process to craft a provision that would provide further incentives to airports to utilize fuel cells in bus, stationary, back up power and ground support applications. We envision a pilot program with committed funding and an increased federal cost share to incentivize airport participation.

Although I'm here to testify on the aviation panel today, I also want to share some of our technology solutions for two prior panels, those addressing surface transportation and public buildings.

SURFACE TRANSPORTATION

Fuel cell transit buses offer the best strategic, near term potential to address energy concerns in surface transportation. In 2002, transit buses consumed the equivalent of more than 43,000 barrels of crude oil per day. The fleet of zero emission hybrid fuel cell buses currently powered by our fuel cells in revenue service in California is demonstrating greater than twice the fuel economy of a conventional diesel bus. We also have a bus in service in our home state of Connecticut, offering an opportunity to cold-weather test our technology. Transit buses and fleet vehicles allow us to begin to reduce oil imports in the near term while also improving air quality and reducing greenhouse gas emissions.

Buses and heavy duty commercial vehicles travel a relatively low percentage of the nation's vehicle miles, but they produce significant levels of toxic air emissions in densely populated urban areas. The transit buses equipped with UTC Power's PureMotion™ 120 fuel cell power system are eliminating overall emissions due to the zero-emissions technology inherent in hydrogen fuel cells.

Fuel cell fleet vehicles also have less demanding requirements and can compete at production unit costs higher than those required by autos. Automobiles and airplanes are geographically more mobile and thus technology change requires additional considerations. We are concentrating on those applications that enhance our ability to establish a profitable industry today and create stepping stones to the most demanding longer term auto application. Few companies can survive the next ten years waiting for the high volumes offered by the car market to develop. Instead, they must find applications where profits can be realized today that will support the development of a strong industrial base in preparation for the future auto market. Success in these early applications can build the necessary public awareness and public confidence.

UTC Power does not see any "show stopper" technical barriers to the advancement of fuel cells, but continued U.S. commitment to research, development, demonstration and market transition initiatives are essential to reduce cost, improve durability and enhance performance. Hydrogen storage and infrastructure requirements represent challenging obstacles for transportation applications, but near term opportunities that minimize these concerns exist with fleet vehicle applications such as transit buses.

We therefore need to increase our immediate focus on near term applications that are available today such as fleet vehicles, including transit buses, to stimulate early volume and build the industry's supplier base. Since fuel cells represent a disruptive technology, the supplier base is reluctant to make the necessary investment. Early successes in the transit bus application will help to overcome these fears.

PUBLIC BUILDINGS

The buildings sector consumes more than 40 percent of the energy produced in the United States and is responsible for nearly 40 percent of greenhouse gas emissions. The generation and transmission of electricity for residential and commercial buildings account for most of this energy use. Climate control accounts for more than a third of total buildings energy consumption worldwide and ranks near the top in total energy uses, and as in many energy applications, significant efficiency gains are possible and achievable. With Carrier's leadership within its industry, the U.S. government raised the minimum electrical efficiency for residential systems sold in the United States by 30 percent.

Moving toward high-performance and sustainable buildings will cut energy consumption and cost; improve human health and productivity through better indoor environmental air quality; provide reliable electricity from on-site renewable and alternative power generation that is less susceptible to disasters and security threats; reduce waste and water use; and reduce the nation's reliance on foreign sources of energy.

A properly constructed energy technology roadmap for commercial buildings can identify actions the private sector and government can take to improve energy efficiency and reduce greenhouse gas emissions. UTC supports legislation that requires the federal government to plan and implement a multiyear national action strategy to reduce commercial building energy use and achieve zero-net-energy commercial buildings. Federal policy should take a whole-building life cycle approach in the design of new and the renovation or retrofitting of existing buildings. The federal government should leverage a wide variety of government policies, partnerships, incentives and support for a broad portfolio of energy technologies to accelerate the transition to net-zero energy buildings. These technologies include, but are not limited to, energy-efficient heating, ventilating and air conditioning systems; advanced combined heat and power systems for distributed generation; stationary fuel cells; building automation, security and communications; and renewable energy sources.

UTC supports the goals of several "green buildings" bills introduced in the 110th Congress. *The Public Buildings Cost Reduction Act of 2007* (S. 992) accelerates efforts to improve the energy efficiency of federal buildings managed by the General Services Administration. In addition, it authorizes the Environmental Protection Agency to establish a grant program to help counties and municipalities increase energy efficiency in their buildings with new techniques and green infrastructure. The bill also establishes within the GSA a centralized program to coordinate cost reduction recommendations, practices, and activities to improve energy efficiency within federal buildings. *The Energy Efficiency Promotion Act of 2007* (S. 1115) requires new and renovated federal buildings to reduce fossil fuel energy consumption by 50 percent compared to existing federal buildings of the same type. Fossil fuel consumption in new and renovated buildings shall be reduced by at least 10 percent every 5 years and by 2030 new and renovated federal buildings are to be "carbon neutral". Other bills create a National Office of Green Buildings, which would act as an advisory organization, coordinating the federal government's green building projects, making standards and best practices publicly available, and making legislative recommendations. Still others create grant programs to help schools become green. High-performance and sustainable buildings legislation provides the opportunity for aggressive action to dramatically improve building energy efficiency.

Let me give you a real world example of how UTC is contributing to increased building energy efficiency. Our Otis Elevator division has shown remarkable innovation. Along with advances that improve the ride for passengers, Otis introduced regenerative drive technology that returns energy to the building's internal electrical grid during elevator system operation. This option makes a Gen2 Elevator system easily the most energy-efficient elevator ever developed – as much as 75% more efficient than conventional elevator drive systems.

SUMMARY

Energy conservation presents the greatest near-term opportunity to reduce both consumption and emissions and should be a high priority for our nation. Currently available technologies can save considerable energy use in a cost-effective manner. New technologies are emerging that can lead to further cost-effective savings. UTC is investing heavily and working in partnership with various government agencies to bring climate friendly technologies to the marketplace that address aviation, surface transportation and building sector emissions.

The federal government should increase its focus on and investment in existing and emerging alternative energy and energy efficiency technologies that have a high potential to be affordable and cost-effective and to gain market acceptance.

In particular, climate change technology research, development, demonstration and deployment programs should focus on:

- Improving energy efficiency and reducing greenhouse gas emissions in transportation, residential and commercial buildings and industrial processes.
- Applying advanced technologies, such as combined heat and power and distributed generation, to the electricity transmission and distribution infrastructure as well as to light, medium and heavy duty transportation applications.

The federal government plays a central role in creating the incentives and adopting the requirements necessary to encourage customers to invest in efficient, clean technologies that will increase our nation's energy independence and security through sustainable means.

Government is also an important customer because its vast purchasing power can help increase volume and reduce costs to levels more competitive with traditional energy sources. Government purchase and deployment of climate change technologies also lends invaluable credibility that, in turn, stimulates private investment.

It is essential to make wise investments in order to expedite innovative and cost-effective approaches to reducing energy demand and greenhouse gas emissions. Such investments are also critical to ensuring and maintaining America's competitive position in energy technology deployment.

UTC looks forward to working with members of this Committee and other stakeholders to ensure the commercialization of advanced energy technologies that provide environmental, climate change, energy security and economic benefits for our nation.

Thank you for the opportunity to testify.